TERMINAL LEARNING OBJECTIVE

ACTION

Troubleshoot the AND, OR, NAND, NOR and XOR gates.

CONDITION

Given a classroom environment, Computer Aided Instruction (CAI) workstation, NIDA 130 Electronic Trainer, Digital Multimeter w/test leads, Digital Logic Probe, PC130-102, PC130-103, PC130-104, PC130-105, PC130-107, PC130-112 and official OMEMS reference material.

STANDARD

Correctly answer 18 of 25 questions concerning AND, OR, NAND, NOR, and XOR gates.

CLASSIFICATION:	UNCLASSFIED
SAFETY CONSIDERATIONS:	ELECTRICAL SHOCK HAZARD
	ELECTOSTATIC DISCHARGE
ENVIRONMENTAL:	NONE
RISK ASSESMENT:	LOW

ENABLING LEARNING OBJECTIVE 1

ACTION

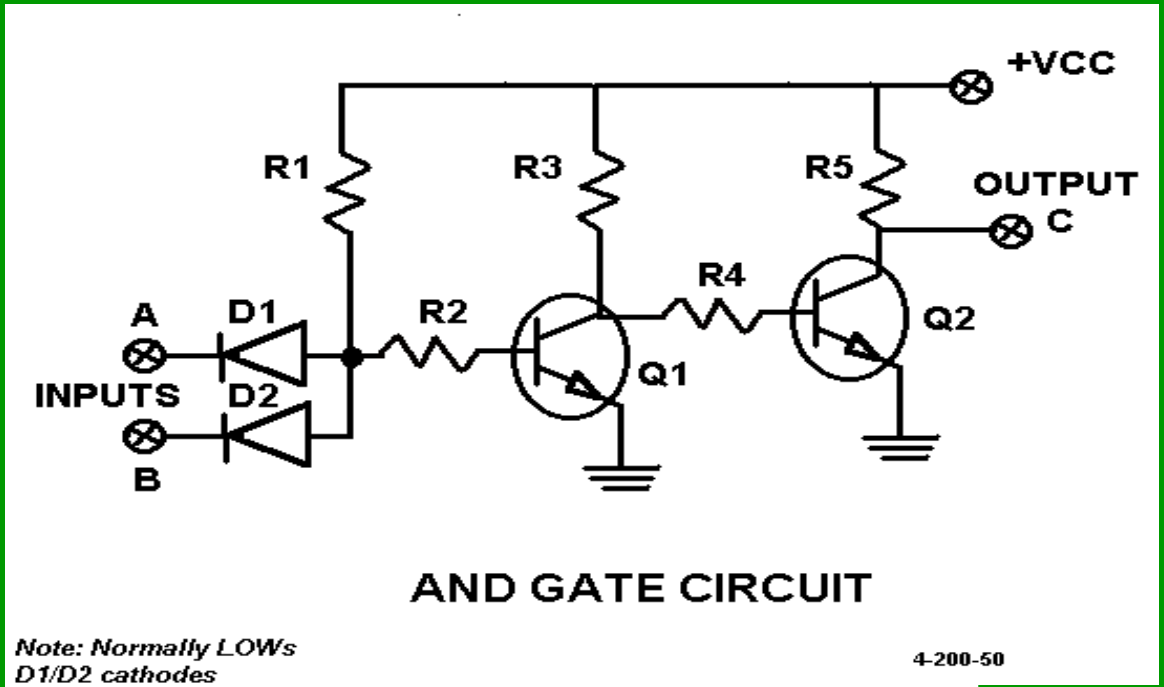
Define the purpose of a truth table, timing chart, Boolean expression, variations, and a simple application of the AND function.

CONDITION

Given a classroom environment, Computer Aided Instruction (CAI) workstation, NIDA 130 Electronic Trainer, Digital Multimeter w/test leads, Digital Logic Probe, PC130-102, PC130-112 and official OMEMS reference material.

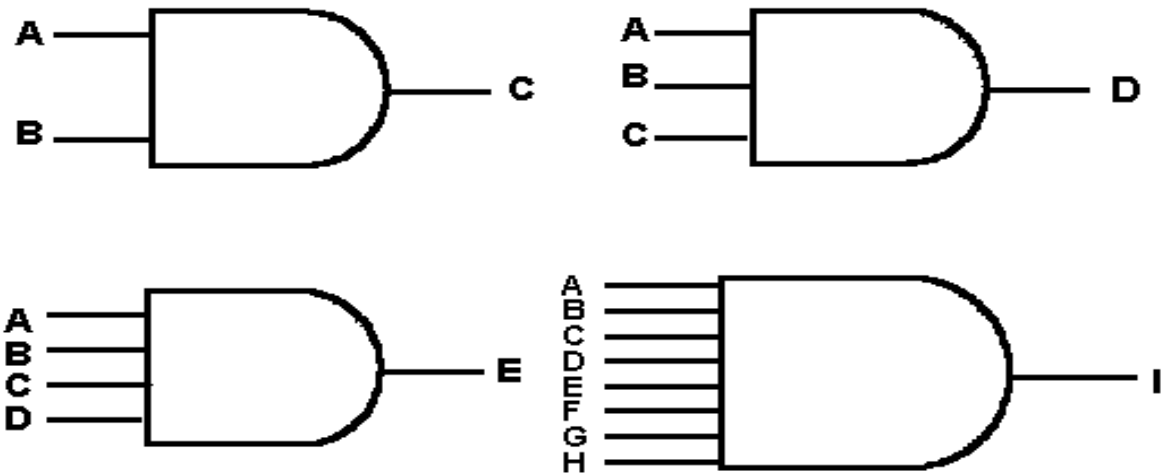
STANDARD

Correctly answer 18 of 25 questions concerning AND, OR, NAND, NOR, and XOR gates.


+VCC
R1
R3
R5
OUTPUT
C
R4
A
D1
R2
Q2
INPUTS
D2
Q1
B
AND GATE CIRCUIT
Note: Normally LOWs
D1/D2 cathodes
4-200-50

ALL INPUTS MUST BE ACTIVE IN ORDER TO MAKE THE OUTPUT ACTIVE

AND gate logic symbol



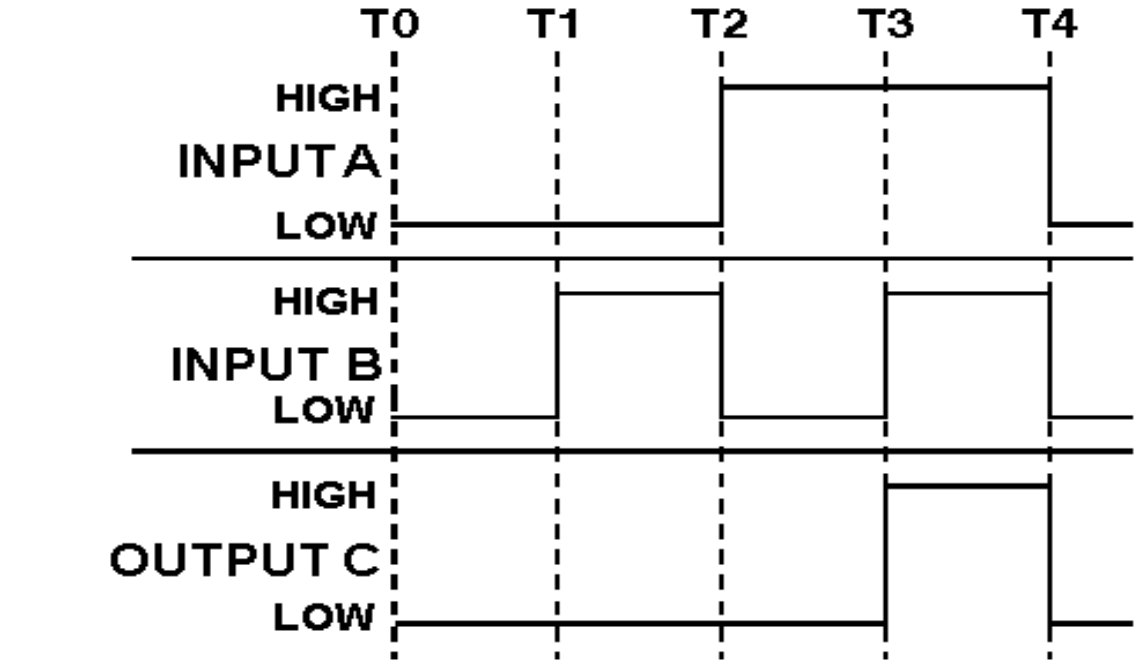
logic symbols for the AND gate

showing 2, 3, 4, and 8 inputs

4-200-06

Input	*Input*	*Output*
L	*L*	
L	*H*	
H	*L*	
H	*H*	

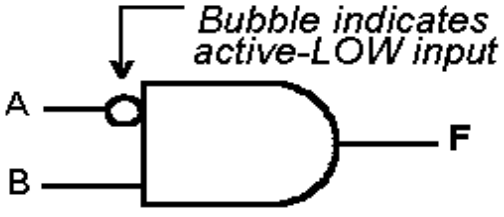
Two input AND gate logic levels


T0
T1
T2
T3
T4
HIGH
INPUT A
LOW
HIGH
INPUT B
LOW
HIGH
OUTPUT C
LOW
4-200-09

$$A \bullet B = F$$

$$[\ AB = F\ ]$$

Logic Expression for AND gate



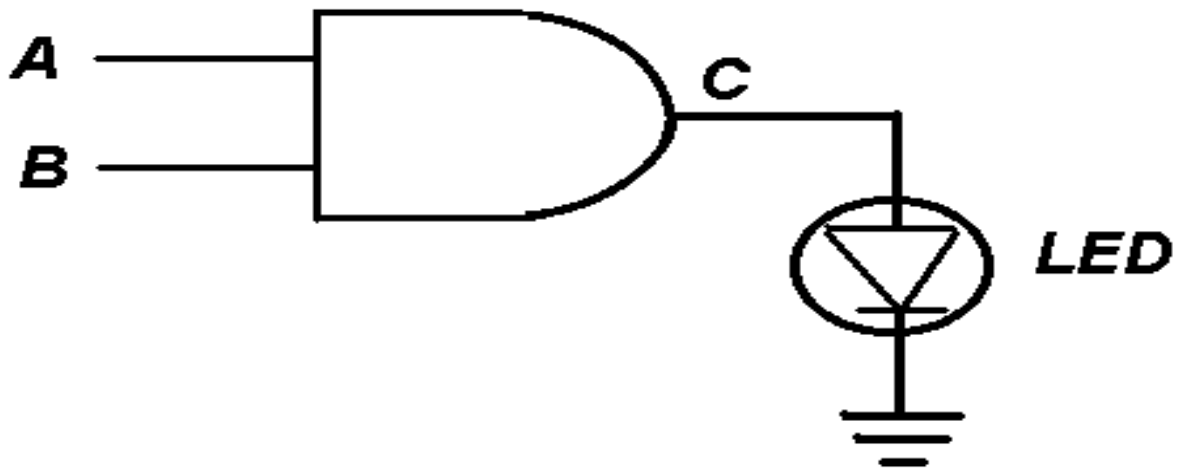
AND VARIATIONS

A	B	F
0	0	
0	1	
1	0	
1	1	

A	B	F
0	0	
0	1	
1	0	
1	1	

A	B	F
0	0	
0	1	
1	0	
1	1	

4-200-08

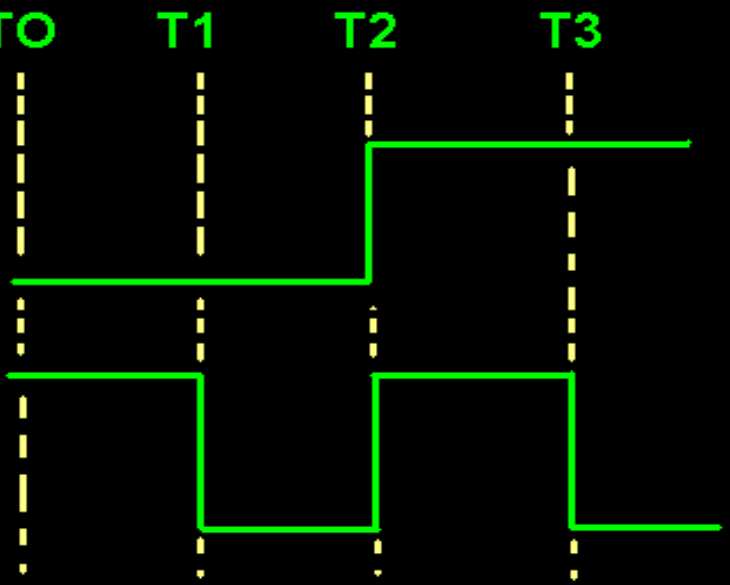


Simple AND gate application

4-200-05

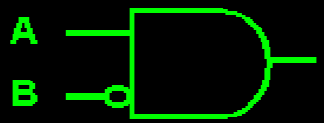
Referring to the figure below, when will the output of an AND gate be HIGH ?

1. T0
2. T1
3. T2
4. T3



What does "F" equal for the circuit shown below ?

1. F = 1111
2. F = 0010
3. F = 0100
4. F = 0000



A	B	F
0	0	
0	1	
1	0	
1	1	

$A\overline{B} = F$

ENABLING LEARNING OBJECTIVE 2

ACTION

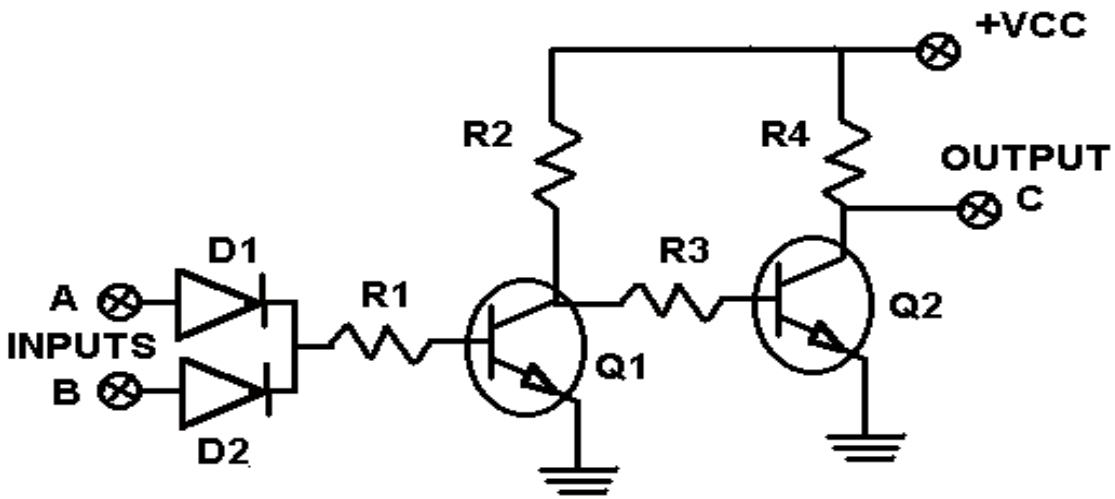
Define the purpose of a truth table, timing chart, Boolean expression, variations, and a simple application of the OR function.

CONDITION

Given a classroom environment, Computer Aided Instruction (CAI) workstation, NIDA 130 Electronic Trainer, Digital Multimeter w/test leads, Digital Logic Probe, PC130-104, PC130-112 and official OMEMS reference material.

STANDARD

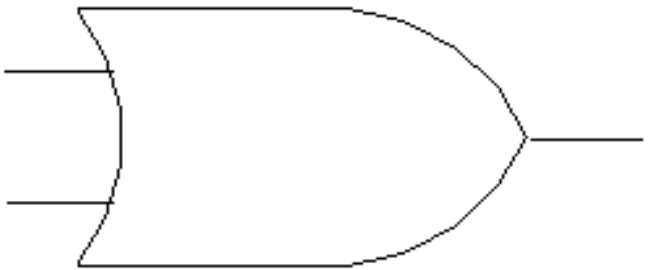
Correctly answer 18 of 25 questions concerning AND, OR, NAND, NOR, and XOR gates.



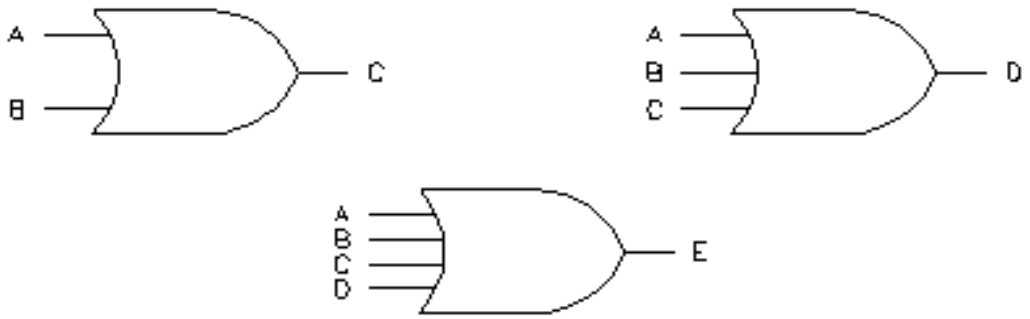
OR GATE CIRCUIT

4-200-51

ANY ACTIVE INPUT WILL
ACTIVATE THE OUTPUT



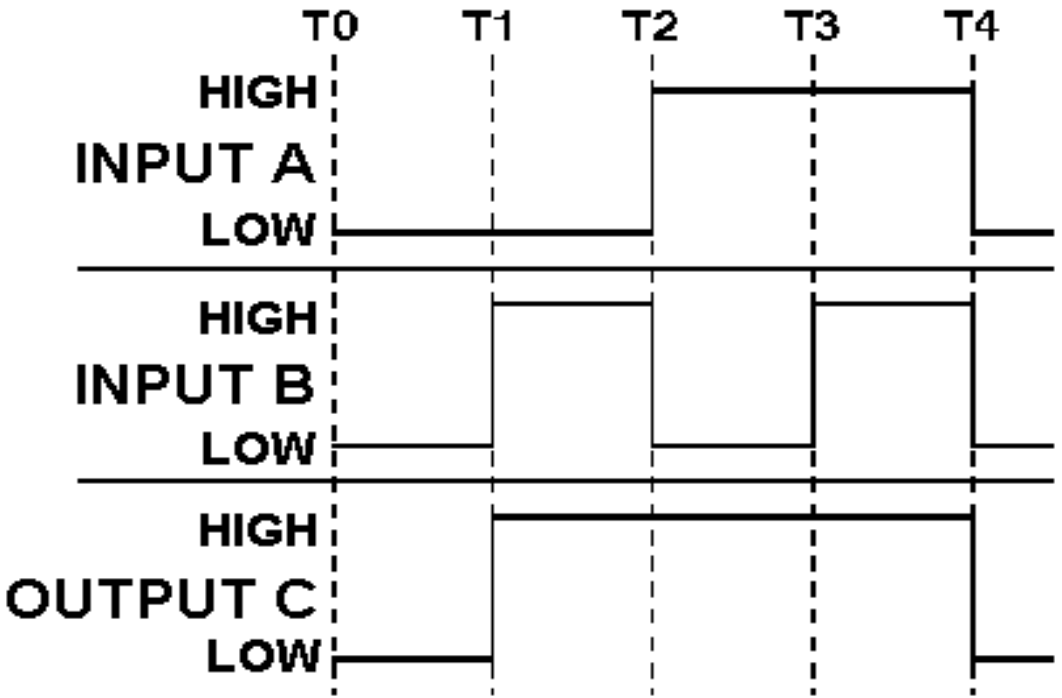
OR gate logic symbol

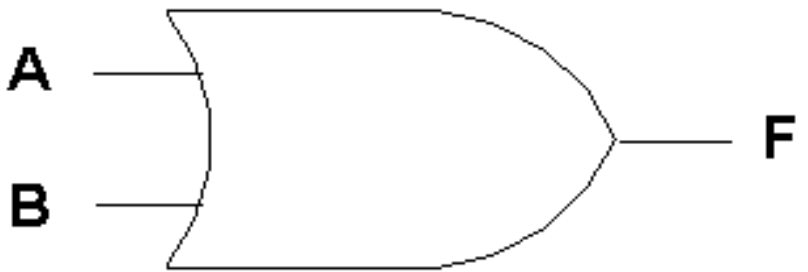


Logic symbols for the OR gate showing 2, 3, and 4 inputs

Input	*Input*	*Output*
L	*L*	
L	*H*	
H	*L*	
H	*H*	

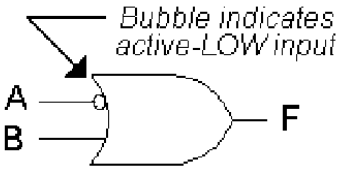
Two input OR gate logic levels

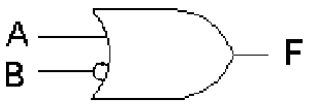

T0
T1
T2
T3
T4
HIGH
INPUT A
LOW
HIGH
INPUT B
LOW
HIGH
OUTPUT C
LOW

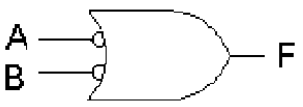


$$A + B = F$$

Logic Expression for OR gate





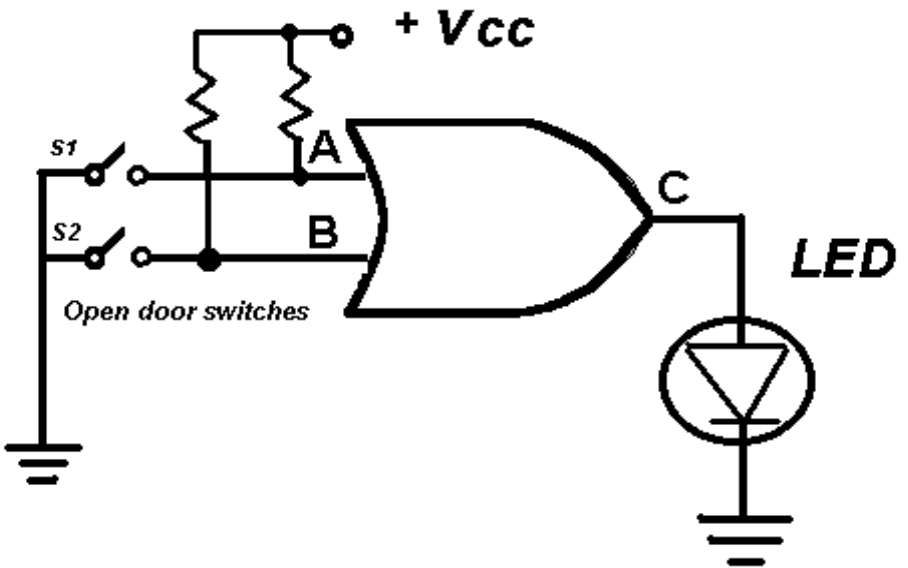


OR VARIATIONS

A	B	F
0	0	
0	1	
1	0	
1	1	

A	B	F
0	0	
0	1	
1	0	
1	1	

A	B	F
0	0	
0	1	
1	0	
1	1	



Simple OR gate application

4-200-12

When is the output from an OR gate active ?

1. When all inputs are HIGH
2. When all inputs are LOW
3. When all inputs are active
4. When any input is active

Fill in the output levels in this truth table for an OR gate.

1. C = 1101
2. C = 1011
3. C = 1001
4. C = 1010

A	B	C
0	1	
1	0	
0	0	
1	1	

4-200-60

ENABLING LEARNING OBJECTIVE 3

ACTION

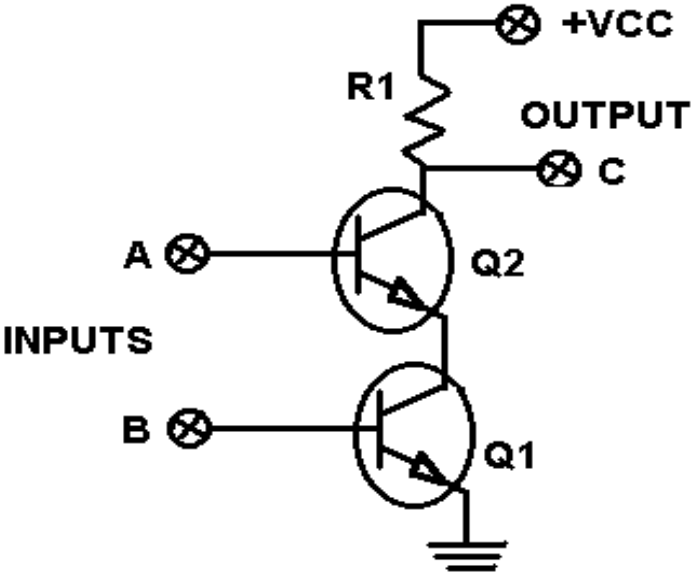
Define the purpose of a truth table, timing chart, Boolean expression, variations, and a simple application of the NAND function.

CONDITION

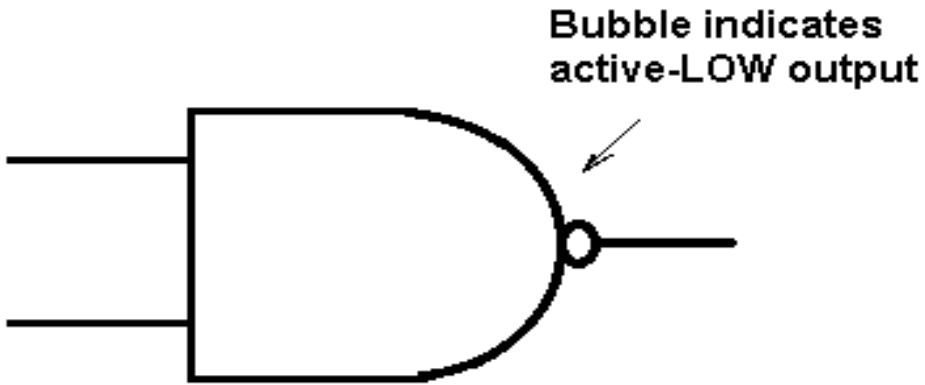
Given a classroom environment, Computer Aided Instruction (CAI) workstation, NIDA 130 Electronic Trainer, Digital Multimeter w/test leads, Digital Logic Probe, PC130-103, PC130-112 and official OMEMS reference material.

STANDARD

Correctly answer 18 of 25 questions concerning AND, OR, NAND, NOR, and XOR gates.

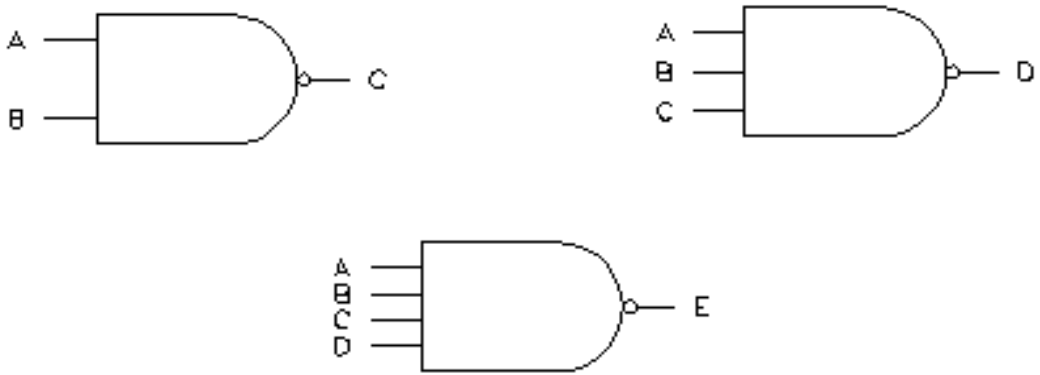


NAND GATE CIRCUIT



NAND gate symbol

ALL INPUTS MUST BE ACTIVE IN ORDER TO MAKE THE OUTPUT ACTIVE

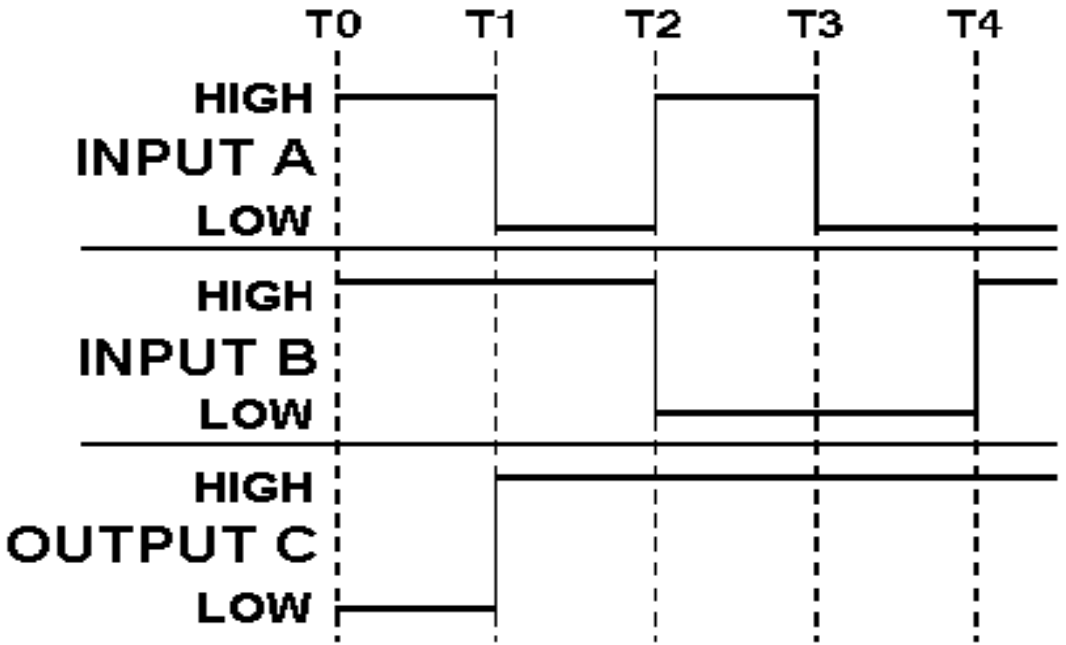


Logic symbols for the NAND gate showing 2, 3, and 4 inputs

Input	*Input*	*Output*
L	*L*	
L	*H*	
H	*L*	
H	*H*	

Two input NAND gate logic level

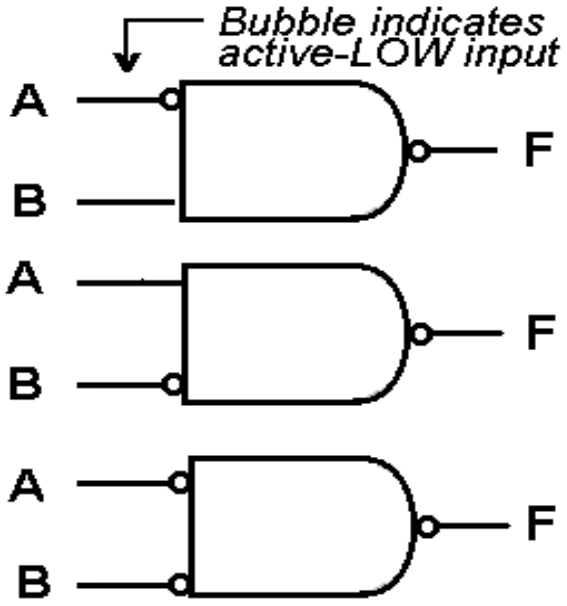
4-200-24


T0
T1
T2
T3
T4
HIGH
INPUT A
LOW
HIGH
INPUT B
LOW
HIGH
OUTPUT C
LOW

$$A \bullet B = \overline{F}$$

$$\overline{AB} = F$$

Logic Expression for NAND gate



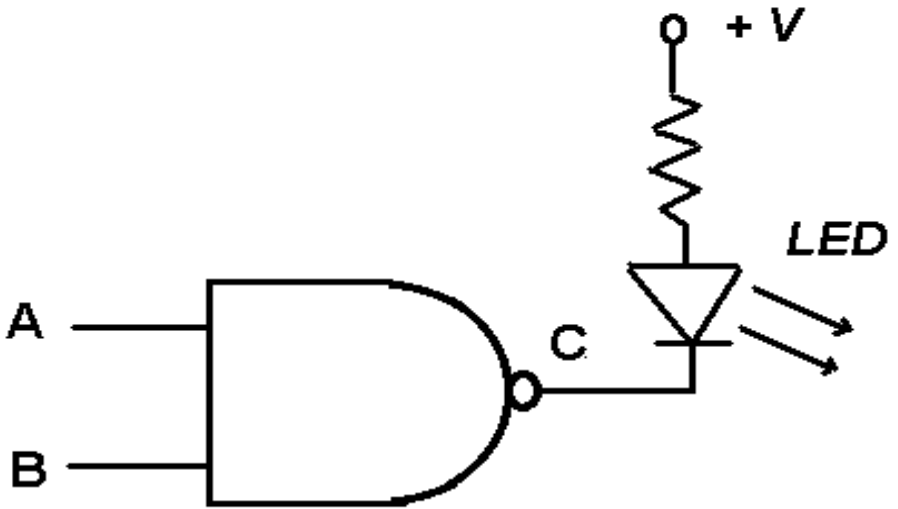
NAND VARIATIONS

A	B	F
0	0	
0	1	
1	0	
1	1	

A	B	F
0	0	
0	1	
1	0	
1	1	

A	B	F
0	0	
0	1	
1	0	
1	1	

4-200-39



Simple NAND gate application

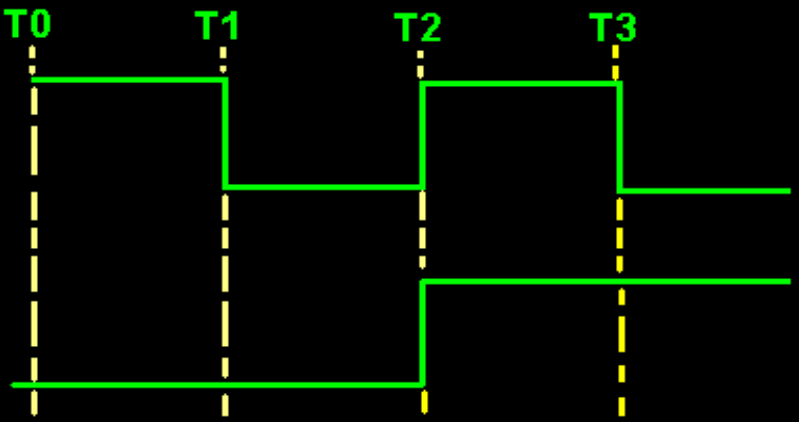
4-200-23

What output does a NAND gate require to be active ?

1. HIGH
2. LOW

Referring to the figure below, when will the output of a NAND gate be HIGH ?

1. TO
2. T0, T1
3. T0,T1,T2
4. T0,T1,T3



4-200-62

ENABLING LEARNING OBJECTIVE 4

ACTION

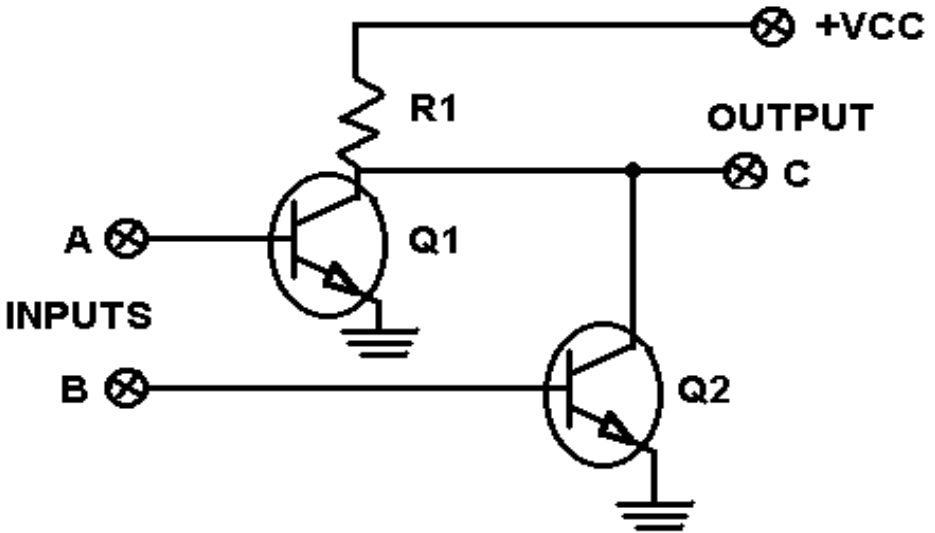
Define the purpose of a truth table, timing chart, Boolean expression, variations, and a simple application of the NOR function.

CONDITION

Given a classroom environment, Computer Aided Instruction (CAI) workstation, NIDA 130 Electronic Trainer, Digital Multimeter w/test leads, Digital Logic Probe, PC130-105, PC130-112 and official OMEMS reference material.

STANDARD

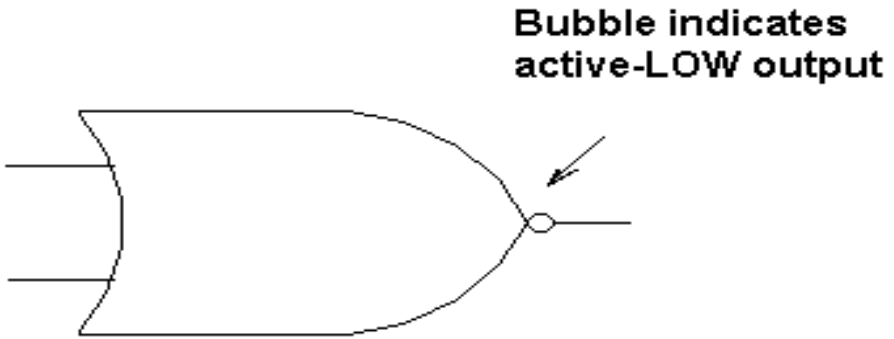
Correctly answer 18 of 25 questions concerning AND, OR, NAND, NOR, and XOR gates.



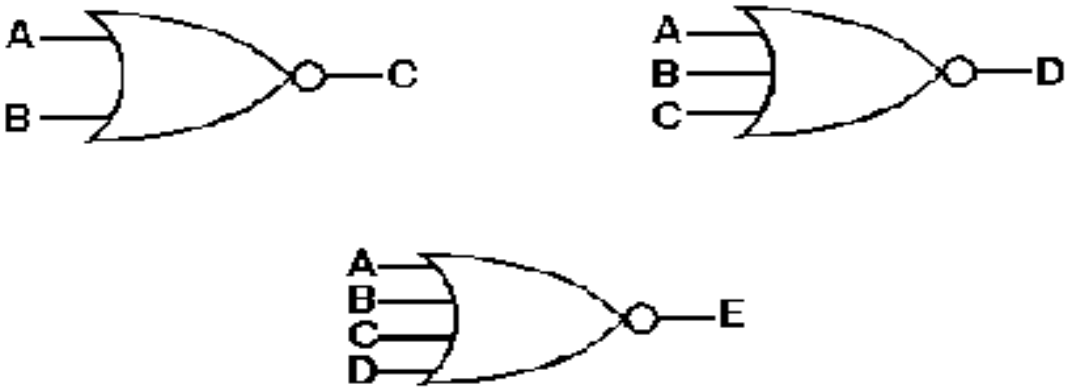
NOR GATE CIRCUIT

4-200-53

ANY ACTIVE INPUT WILL
ACTIVATE THE OUTPUT



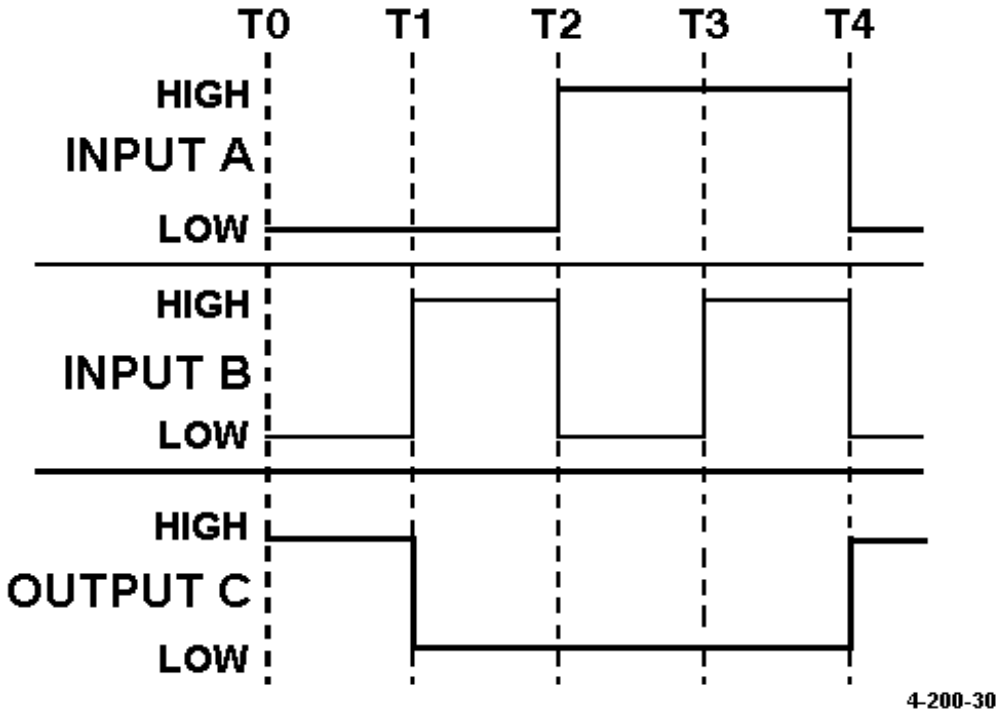
NOR gate logic symbol

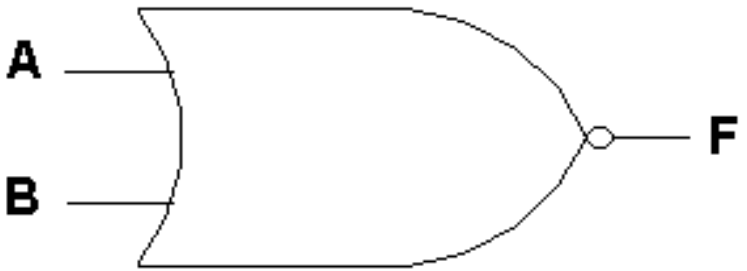


Logic symbols for the NOR gate showing 2, 3, and 4 inputs

Input	*Input*	*Output*
L	*L*	
L	*H*	
H	*L*	
H	*H*	

Two input NOR gate logic levels

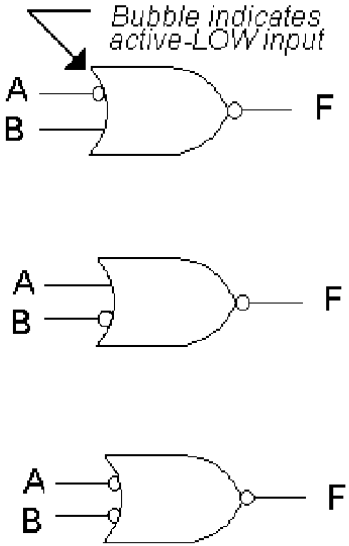

T0
T1
T2
T3
T4
HIGH
INPUT A
LOW
HIGH
INPUT B
LOW
HIGH
OUTPUT C
LOW
4-200-30



$$A + B = \overline{F}$$

$$\overline{A + B} = F$$

Logic Expression for NOR gate

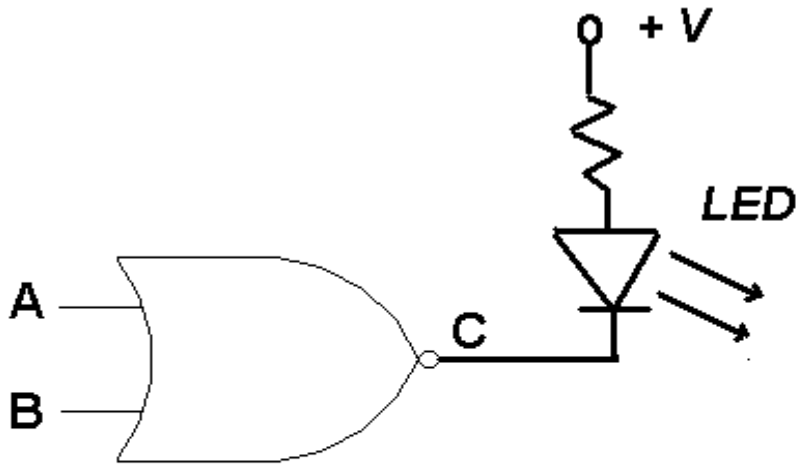


A	B	F
0	0	
0	1	
1	0	
1	1	

A	B	F
0	0	
0	1	
1	0	
1	1	

A	B	F
0	0	
0	1	
1	0	
1	1	

NOR VARIATIONS

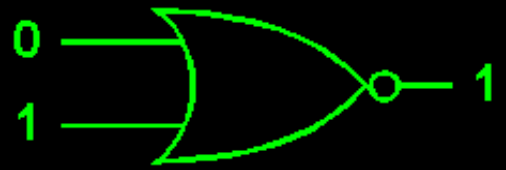


Simple NOR gate application

4-200-41

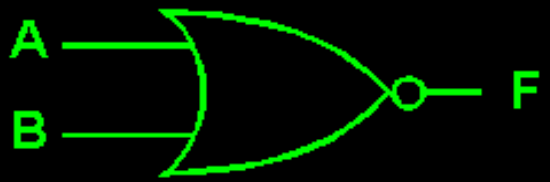
Is the NOR gate in the figure below operating correctly ?

1. Yes
2. No, the output is incorrect
3. No, the input is incorrect
4. Cannot determine



What does "F" equal for the circuit shown below ?

1. F = 0111
2. F = 0001
3. F = 1110
4. F = 1001



A	B	F
0	0	
0	1	
1	0	
1	1	

A + B = F

ENABLING LEARNING OBJECTIVE 5

ACTION

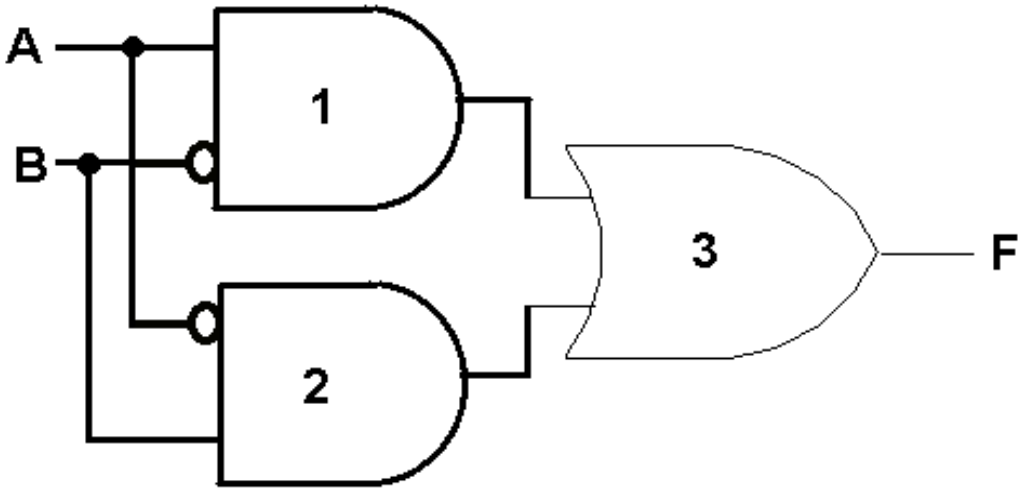
Define the purpose of a truth table, timing chart, Boolean expression, variations, and a simple application of the XOR function.

CONDITION

Given a classroom environment, Computer Aided Instruction (CAI) workstation, NIDA 130 Electronic Trainer, Digital Multimeter w/test leads, Digital Logic Probe, PC130-107, PC130-112 and official OMEMS reference material.

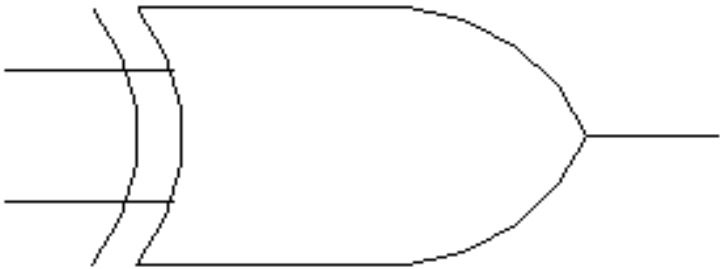
STANDARD

Correctly answer 18 of 25 questions concerning AND, OR, NAND, NOR, and XOR gates.

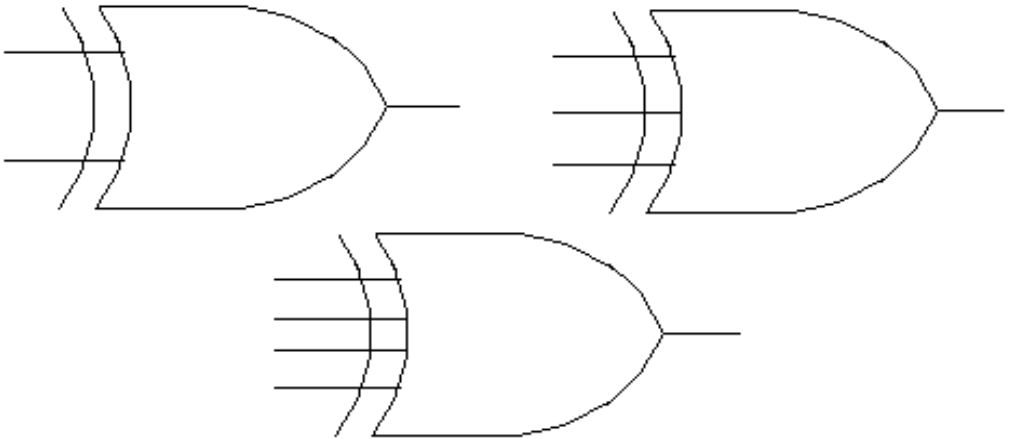


XOR GATE CIRCUIT

ONE INPUT MUST BE ACTIVE AND ONE INPUT MUST BE INACTIVE TO MAKE THE OUTPUT ACTIVE



XOR OR gate logic symbol

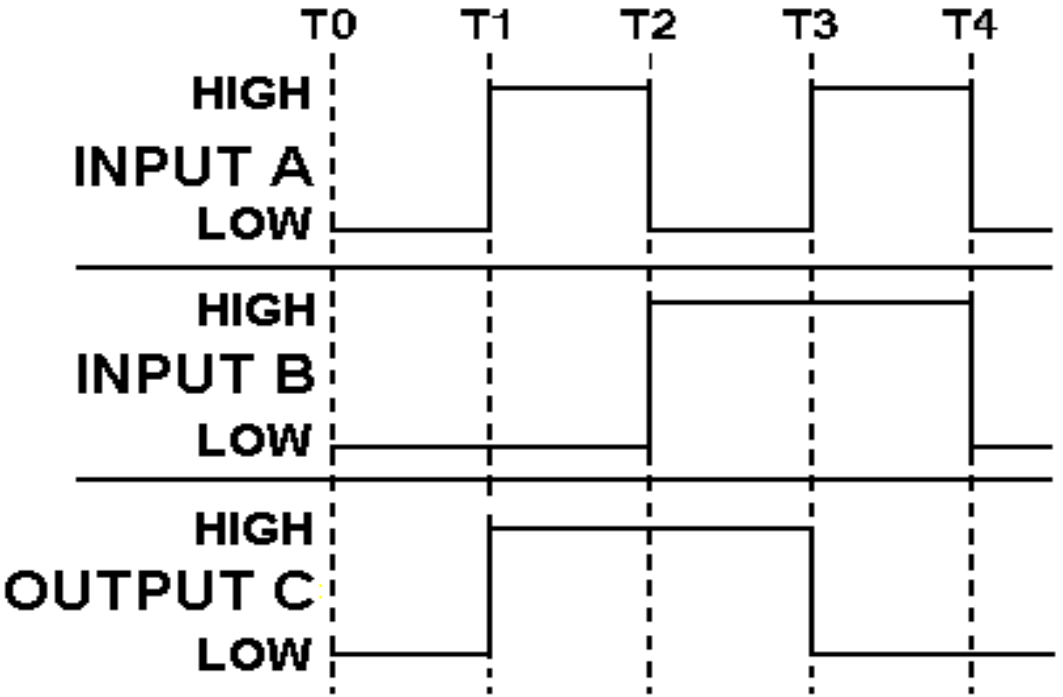


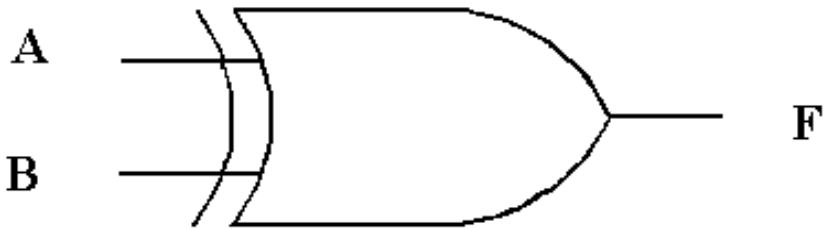
Logic symbols for XOR gate showing 2, 3, and 4 inputs

4-200-56

Input	*Input*	*Output*
L	*L*	
L	*H*	
H	*L*	
H	*H*	

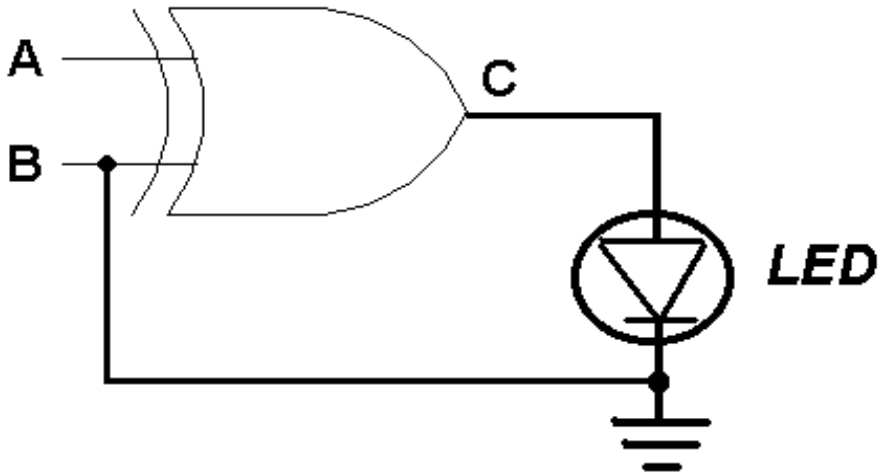
Two input Exclusive OR gate logic levels


T0
T1
T2
T3
T4
HIGH
INPUT A
LOW
HIGH
INPUT B
LOW
HIGH
OUTPUT C
LOW



$A \oplus B = F$

Logic Expression for Exclusive OR gate



Simple Exclusive OR gate application

4-200-45

To produce a HIGH output from a two input XOR gate, input A must be _____ and input B must be _____.

1. HIGH, HIGH

2. HIGH, LOW

3. LOW, LOW

What does "F" equal for the circuit shown below ?

1. F = 1001
2. F = 1100
3. F = 0011
4. F = 0110

A	B	F
L	L	
L	H	
H	L	
H	H	

$A \oplus B = F$

4-200-66

ENABLING LEARNING OBJECTIVE 6

ACTION

Perform signal logic tracing of the five basic gates.

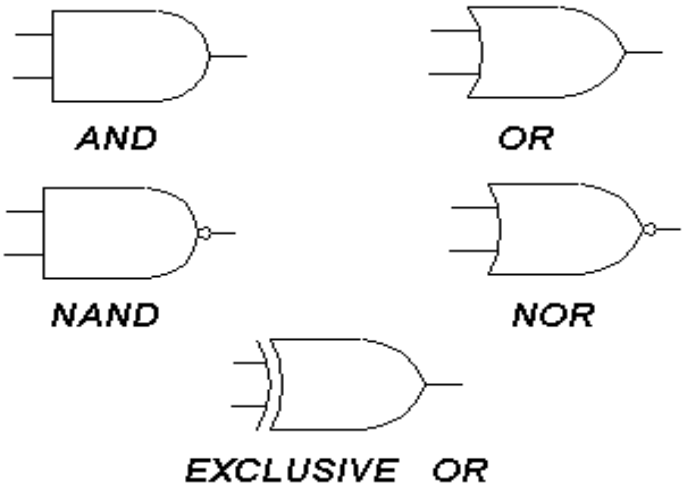
CONDITION

Given a classroom environment, Computer Aided Instruction (CAI) workstation, NIDA 130 Electronic Trainer, Digital Multimeter w/test leads, Digital Logic Probe, PC130-107, PC130-112 and official OMEMS reference material.

STANDARD

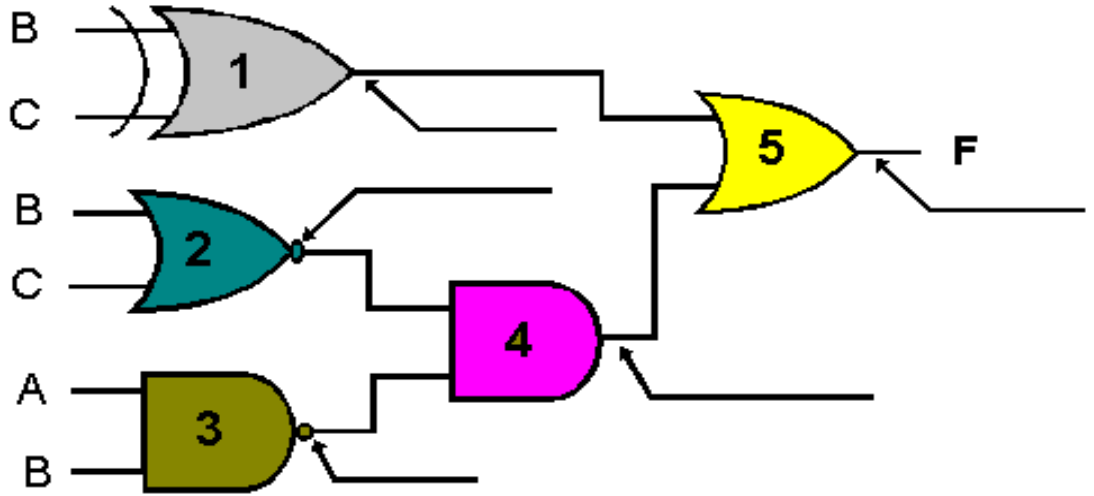
Correctly answer 18 of 25 questions concerning AND, OR, NAND, NOR, and XOR gates.

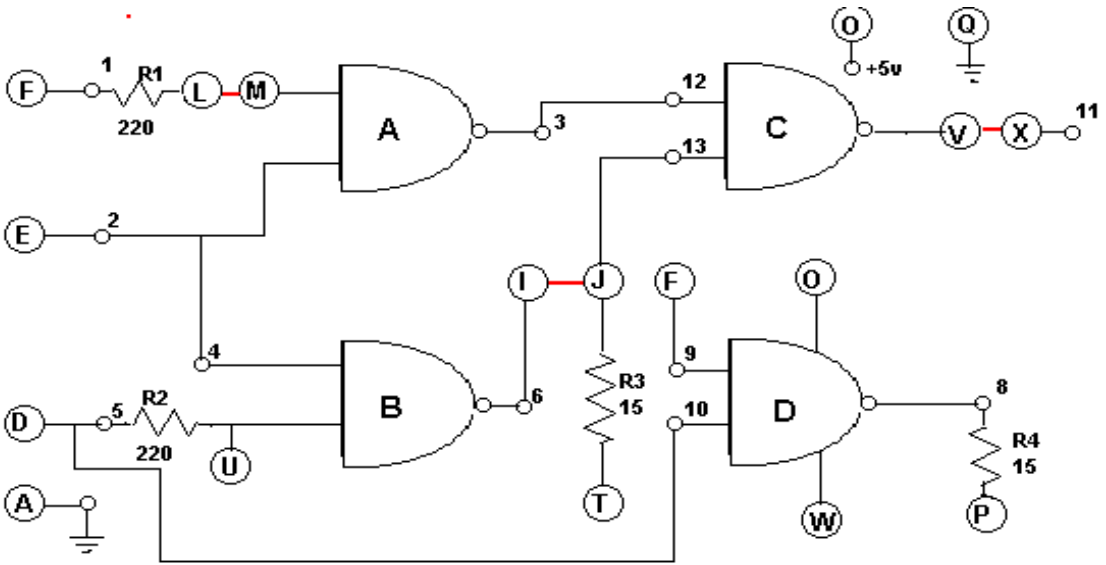
LOGIC TRACING



Digital Logic Gates

Write the signal expressions that exist on each line of the circuit.




F
1
R1
220
L
M
A
3
12
13
C
O
+5v
Q
V
X
11
E
2
I
J
F
O
4
B
9
R3
15
D
8
R4
15
D
5
R2
220
6
10
U
T
W
P
A

CCA 103

ENABLING LEARNING OBJECTIVE 7

ACTION

Complete CAI Lessons on the AND, OR, NAND, NOR, and XOR gates.

CONDITION

Given a classroom environment, Computer Aided Instruction (CAI) workstation, NIDA 130 Electronic Trainer, Digital Multimeter w/test leads, Digital Logic Probe, PC130-107, PC130-112 and official OMEMS reference material.

STANDARD

Correctly answer 18 of 25 questions concerning AND, OR, NAND, NOR, and XOR gates.

ENABLING LEARNING OBJECTIVE 8

ACTION

Troubleshoot the AND, OR, NAND, NOR and XOR gates.

CONDITION

Given a classroom environment, Computer Aided Instruction (CAI) workstation, NIDA 130 Electronic Trainer, Digital Multimeter w/test leads, Digital Logic Probe, PC130-107, PC130-112 and official OMEMS reference material.

STANDARD

Correctly answer 18 of 25 questions concerning AND, OR, NAND, NOR, and XOR gates.